

# Investment Analysis of Cross-Border Interconnections of European Power System

With the DC-Power Flow model, grid bottlenecks for a future electricity-production system can be identified and different grid reinforcement options can be evaluated. Analysis of a business as usual case indicates several potential bottlenecks in the European transmission system, unless investments in the grid are undertaken. Profitable grid reinforcement options to avoid the bottlenecks are also identified.

## Model for analyzing the power grid

Within the Pathways project, a complete modeling package for analyzing the power-generation system has been developed (see Newsletter 1, 2010). Included in this package is the DC-Power Flow model which uses the hourly electricity production estimated by the EPOD model as input. The DC-Power Flow model provides a detailed description of the electricity-transmission grid in the EU. Hence, this model is an efficient tool to identify grid bottlenecks and can also be used to evaluate grid reinforcements needed (or alternative generation siting) in the future European power system. Here a cost-benefit analysis of a business as usual (BAU) case is presented.

## Bottlenecks identified

The grid situation in BAU is presented in Figure 1. Due to congested lines there is not a common price for the whole system, and three price zones can be identified: red for expensive, blue for cheap and green for middle price zone. The most expensive area is the one corresponding to Italy implying that large amounts of power is transferred to the South from neighboring areas.

Germany, together with France, is the major exporter of the system and the most critical lines of the network seem to be the cross-border connections from Germany. The strategic position of Slovenia makes it a significant arbitrator facilitating the flows from the north to Italy and to the south Eastern Europe.

## Profitable transmission reinforcements

According to the aforementioned observations five transmission expansion scenarios have been assessed as shown in Table 1. Cost-benefit analyses are performed for all scenarios, where the discounted investment costs are weighted against the

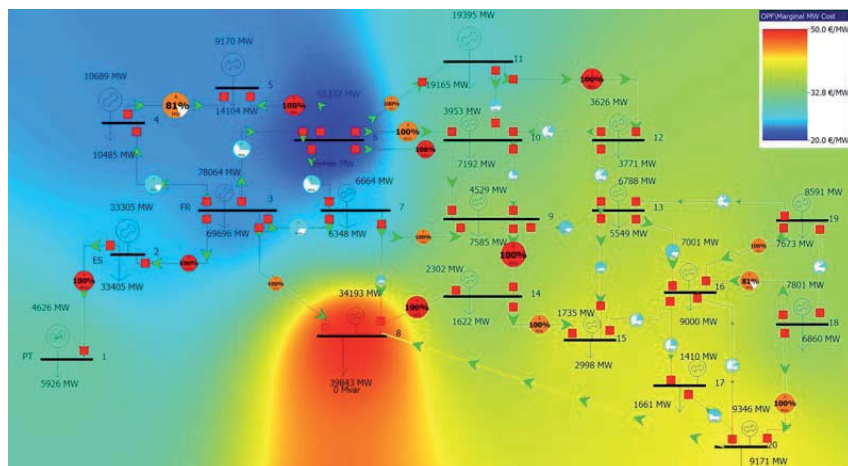


Figure 1: Price zones and congested lines in Europe (BAU)

discounted benefits from the proposed transmission project (the environmental benefits and the reduction of congestion costs in the network). The cost-benefit analyses show that all the scenarios are profitable for the whole analyzed period (2008-2032). The second scenario is assessed the most profitable among the scenarios even though it's not the cheapest alternative.

Table 1: Candidate transmission scenarios

	From	To	actual tran. capacity (MW)	additional tran. capacity (MW)	Inv. costs (M€)
scenario 1	7 (CH)	9 (AT)	1200	3000	500
	7 (CH)	8 (IT)	3890	5000	
	6 (DE)	9 (AT)	2000	4000	
	1 (PT)	2 (ES)	1300	2000	
scenario 2	6 (DE)	9 (AT)	2000	3000	365
	14 (SL)	15 (HR)	900	2000	
	6 (DE)	10 (CZ)	2300	4000	
scenario 3	9 (AT)	14 (SL)	650	1300	400
	6 (DE)	5 (NL)	3000	4000	
	6 (DE)	10 (CZ)	2300	4000	
	1 (PT)	2 (ES)	1300	2000	
scenario 4	6 (DE)	10 (CZ)	2300	4000	620
	6 (DE)	11 (PL)	1200	3000	
	1 (PT)	2 (ES)	1300	2000	
scenario 5	9 (AT)	14 (SL)	650	1500	300
	11 (PL)	12 (SK)	550	1500	
	6 (DE)	9 (AT)	2000	4000	

## The Policy Pathway will reduce the stress on the grid

In the Policy pathway, which targets both CO<sub>2</sub> emission reductions and large demand-side efficiency improvements, the total electricity generation decreases. This, in turn, will reduce the stress in the future transmission systems.

Therefore, the need for new investment will be lower with the Policy pathway. In the Market pathway, on the other hand, only targets for CO<sub>2</sub> emissions are postulated and focus is on mitigation measures in the energy supply-side sectors. The pathway suggests large structural changes with an increased demand of electricity. Obviously, the need for investment will, in most cases, be higher than in the Policy pathway. In whichever pathway, the method presented in this work will be applicable and provide important information.